EFFECTS OF RENEWABLE INVESTMENT AND EXCHANGE RATE ON SUSTAINABLE DEVELOPMENT IN NIGERIA

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Abstract
Inability to effectively adapt to climate change and transit at the necessary speed is a major challenge for developing countries. In Nigeria, the rising population has escalated energy demands. However, the country is endowed with substantial renewable resources that remain largely untapped for sustainable development. This study, investigated the effect of renewable investment (RI) and exchange rate (ER) on two sustainable development goals (child mortality and CO2 emission reduction) from 2000 to 2023. Among others, the study used the Autoregressive Distributed Lag (ARDL) long and short run forms technique to estimate the effect of renewable investment variables, namely renewable energy investment (REIV) and renewable investment in agriculture and afforestation (RAIV) and foreign exchange rates, namely nominal effective exchange rate (NEER) and real exchange rate (REER) on sustainable development indicators, under 5 child mortality rate (MORT) and CO2 emission (CO2E). In the short run, the ARDL results show that LOGRAIV has a significant negative effect on MORT (coefficient = -1.816061; p = 0.0343), NEER has a significant negative effect on MORT (coefficient = -0.009240; p = 0.0005). There was no significant relationship between any of RI and ER variables on MORT in the long run. On CO2 emission, LOGREIV has a significant negative impact (coefficient = -2.364818, p = 0.0000) in the short run and NEER exerted a negative and significant effect on LOGCO2E (coeff = -0.000254, p = 0.0170). In the long run, LOGREIV has a negative and significant effect on LOGCO2E (-4.189907, p = 0.0081). Additionally, LOGRAIV significantly reduced LOGCO2E, with a coefficient of -0.614177 (p = 0.0384). Based on these findings, we conclude that RI and ER have greater effect on sustainable development in the short run than in the long run. It is hereby recommended that Nigerian governments should continue to prioritize and increase investments in renewable energy, ensure stable exchange rate, and sustainable agricultural practices, thereby developing robust policy frameworks to integrate renewable energy and sustainable agriculture into broader economic and environmental strategies which will drive sustainable development.

Key words: *Renewable Investment, Exchange Rate, Sustainable Development, ARDL, CO2 Emission, Renewable Energy.*

Introduction

Sustainable development is a critical goal for Nigeria, particularly in light of the country's economic, environmental, and social challenges. The integration of renewable energy investments into the national development strategy offers a promising pathway to sustainable development, as these investments can help address the energy deficit while promoting environmental sustainability. However, the impact of renewable energy investments on sustainable development is intricately linked to the dynamics of exchange rates, which play a crucial role in determining the cost of imported technology, the viability of foreign direct investments (FDIs), and overall economic stability (UNCTAD, 2024). Globally, the need to diversify the energy mix and reduce dependence on fossil fuels has led to increased attention to investment in renewable energy. Governments, through various policies and initiatives, have sought to attract investments in renewable energy, particularly in solar, wind, and hydropower projects. These efforts align with the global shift towards cleaner energy sources and the United Nations Sustainable Development Goals (SDGs), particularly SDG 7, which focuses on affordable and clean energy for all (World Economic Forum, 2023).

The potential of renewable energy in Nigeria is significant, given the country's abundant natural resources. For instance, the northern region of Nigeria receives high levels of solar radiation, making it an ideal location for solar energy projects (Ohunakin et al., 2014). Similarly, Nigeria's extensive river networks provide opportunities for small and large-scale hydropower projects. These renewable energy sources offer a sustainable alternative to the current reliance on fossil fuels, which contribute to environmental degradation and climate change (Olufemi & Akinyele, 2021). Renewable energy sector has the potential to generate employment opportunities across the value chain, from manufacturing and installation to maintenance and operation (Adewuyi & Awopone, 2020). This can lead to inclusive economic growth, which is a key component of sustainable development. Additionally, by reducing the reliance on fossil fuels, renewable energy investments can help mitigate the environmental impact of energy production, contributing to the preservation of natural ecosystems and the reduction of carbon emissions (Odeyemi & Ogunseitan, 2019). The effectiveness of renewable energy investments in driving sustainable development is contingent on several factors, including the availability of financing, the regulatory environment, and the capacity to maintain and operate renewable energy infrastructure.

Fluctuations in the exchange rate can significantly impact the cost of importing renewable energy technologies, thereby affecting the overall viability and sustainability of these projects (Asuquo, 2012). Exchange rate volatility can impact the flow of foreign direct investments (FDIs) into the renewable energy sector. Investors are often wary of entering markets with high exchange rate volatility due to the uncertainty it introduces in terms of returns on investment (ROI) (Egbo, 2019). In Nigeria, where the exchange rate has been subject to significant fluctuations, this uncertainty can deter potential investors from committing to long-term renewable energy projects, thereby hindering the growth of the sector. On the other hand, a stable exchange rate environment can enhance the attractiveness of renewable energy investments by providing a more predictable and stable investment climate. Stability in the exchange rate can reduce the cost of imported technologies and encourage more FDIs into the renewable energy sector. This, in turn, can lead to increased capacity for renewable energy generation, which is essential for achieving sustainable development (Ezeabasili et al., 2012).

Objectives

This research is to examine the effects of renewable investments and exchange rates on sustainable development in Nigeria, focusing on child mortality rate and carbon emissions as key indicators. Using the ARDL model, the study will analyze both short-term and long-term relationships between these variables. The findings will reveal whether renewable investments in agriculture and forestry reduce child mortality in the short run, and whether investments in renewable energy effectively decrease carbon emissions in both the short and long run. Additionally, the nominal effective exchange rate impact on child mortality in the short run will also be determined. The twin effects of renewable investments and exchange rate fluctuations on sustainable development in Nigeria will be evaluated.

Literature Review

Renewable Investment

Renewable investment refers to the allocation of capital towards energy projects that generate power from renewable sources such as solar, wind, hydro, and biomass. In Nigeria, renewable investment has gained increasing attention as the country seeks to diversify its energy sources and reduce reliance on fossil fuels. This shift is critical due to the environmental benefits of renewable energy, including reduced greenhouse gas emissions and minimized environmental degradation (Ameyaw et al., 2016). The country's vast renewable energy potential, especially in solar and wind, presents significant opportunities for investors. Investment in renewable energy is seen as essential for sustainable economic growth in Nigeria. However, the sector faces several challenges, including inadequate infrastructure, policy inconsistencies, and limited access to financing (Akuru & Okoro, 2014). The Nigerian successive governments has introduced several initiatives, such as the Renewable Energy Master Plan, to encourage investment in the sector. Despite these efforts, the uptake of renewable investment has been slow, partly due to the high upfront costs associated with renewable energy projects and the perceived risks by investors (Oyewo et al., 2021).

Moreover, renewable investment is closely linked to sustainable development goals (SDGs), particularly SDG 7, which emphasizes access to affordable, reliable, sustainable, and modern energy for all. Expanding renewable energy in Nigeria could significantly contribute to achieving this goal by increasing energy access, especially in rural areas, and fostering economic development (Akinbami et al., 2022). Additionally, renewable energy projects can create jobs, reduce energy poverty, and support the transition towards a low-carbon economy.

Exchange Rate Fluctuations

Exchange rate fluctuations refer to the variations in the value of a country's currency relative to other currencies. In Nigeria, exchange rate volatility has been a persistent issue, driven by factors such as fluctuating oil prices, inflation, and economic instability. A country’s currency instability has significant implications for investment, particularly in sectors such as renewable energy, where capital-intensive projects often require foreign investment (Aisen et al., 2021). Exchange rate fluctuations can increase the cost of importing equipments and technology for renewable energy projects, thereby discouraging investment in the sector (Balogun & Agba, 2020). Depreciation of the naira can lead to higher repayment costs for loans denominated in foreign currencies, thereby increasing the financial burden on renewable energy projects (Adewuyi & Awodumi, 2017). Moreover, exchange rate volatility can affect the pricing of electricity generated from renewable sources, making it less competitive compared to fossil-fuel-based energy. This price uncertainty may reduce the attractiveness of renewable investments in Nigeria, where the energy market is already characterized by low tariffs and limited purchasing power (Ogunleye & Oseni, 2019). The impact of exchange rate fluctuations on renewable energy investment is, therefore, a critical concern for policymakers and investors alike.

Iyoha et al, (2020), averred that exchange rate fluctuations negative effect can be mitigated in Nigeria by stabilizing the macroeconomic environment and adopting policies that promote currency stability. This could involve diversifying the economy away from oil dependence, implementing sound monetary policies, and improving the business environment to attract more foreign direct investment (FDI) into the renewable energy sector.

Sustainable Development

Sustainable development in Nigeria encompasses economic growth, social inclusion, and environmental protection, aligned with the United Nations Sustainable Development Goals (SDGs). The concept aims to meet the needs of the present without compromising the ability of future generations to meet their own needs (UNDP, 2022). In the context of renewable investment and exchange rate fluctuations, sustainable development implies a balanced approach to economic development that prioritizes clean energy and mitigates the negative impacts of currency instability on long-term growth.

Renewable energy investment is crucial for achieving sustainable development in Nigeria. The reliance on fossil fuels has led to significant environmental degradation, contributing to climate change and public health issues (Olayinka et al., 2017). By investing in renewable energy, Nigeria can reduce its carbon footprint, improve air quality, and enhance energy security. Furthermore, renewable energy projects can generate employment, improve access to energy in rural areas, and reduce energy poverty, which are essential components of social inclusion (Ajayi & Ajanaku, 2018). However, achieving sustainable development in Nigeria requires overcoming several challenges, including the volatility of the exchange rate. Exchange rate fluctuations can undermine the economic stability needed to support long-term investments in renewable energy and other sustainable development initiatives (Olawuyi, 2020). For instance, currency depreciation can increase the cost of importing renewable energy technologies, thereby reducing the feasibility of these projects and delaying the transition to a green economy. Moreover, sustainable development in Nigeria is contingent on effective governance, sound economic policies, and international cooperation. The government must implement policies that support renewable energy investment, stabilize the exchange rate, and promote environmental sustainability. Additionally, partnerships with international organizations and the private sector are essential for mobilizing the resources needed to achieve sustainable development goals (Nwokocha & Atagana, 2017).

The Interconnectivity of Renewable Investments, Exchange Rate, and Sustainable Development

Complex interconnections exist between renewable investments, exchange rate, and sustainable development. Theoretically, and reasonably so, renewable energy investments should contribute to sustainable development by providing clean energy, reducing environmental degradation, and promoting economic growth. However, the extent to which these investments can drive sustainable development is influenced by exchange rate dynamics. Where the exchange rate is stable, renewable energy projects are likely to be more cost-effective and attractive to investors. This can lead to an increase in renewable energy capacity, which is essential for meeting the energy needs of the population and supporting economic activities. In turn, this can contribute to sustainable development by promoting inclusive economic growth, reducing poverty, and mitigating the environmental impact of energy production (Ubi et al., 2012).

Conversely, in a scenario where the exchange rate is highly volatile, the cost of renewable energy projects may increase, making them less attractive to investors. This can result in a slowdown in the growth of the renewable energy sector, which can have negative implications for sustainable development. High project costs may lead to delays in the implementation of renewable energy projects, which can impede the achievement of energy access goals and limit the potential for economic growth (Omotosho et al., 2018). Cherif et al. (2020) stated that one of the most significant barriers to sustainable development is the volatility of the exchange rate, which increases the cost of importing the necessary technologies and materials for renewable energy projects. According to the authors, exchange rate fluctuations create uncertainty for investors, leading to higher perceived risks and a reluctance to commit capital to long-term renewable energy projects. For Okoro and Akuru (2014), another barrier is the lack of adequate infrastructure to support renewable energy deployment. Nigeria's power grid is underdeveloped and unreliable, making it difficult to integrate renewable energy sources into the national energy mix (Oyewo et al., 2021). According to Oyewo et al., (2021), the regulatory environment in Nigeria is often characterized by policy inconsistency and weak enforcement of existing regulations, which discourages investment in renewable energy.

Theoretical Literature

Theory of Investment under Uncertainty

Developed by McDonald and Siegel (1986), the theory provides a framework for understanding how investors make decisions in the face of uncertain future returns. This theory is particularly relevant to renewable energy investment in Nigeria, where exchange rate volatility and other economic uncertainties can significantly impact investment decisions. According to the theory, when investors face uncertainty, they tend to delay investments to gather more information, especially when the investment is irreversible or associated with high sunk costs (Dixit & Pindyck, 1994). In the context of renewable energy investment in Nigeria, the theory suggests that exchange rate fluctuations can act as a deterrent to investment. Investors may hesitate to commit funds to renewable energy projects if they anticipate further currency depreciation, which could increase the costs of imported equipment and reduce the expected returns on investment. This hesitation can lead to a "wait-and-see" approach, where investments are postponed until there is greater certainty in the economic environment (Baker et al., 2022).

Moreover, the theory highlights the importance of government policy in mitigating investment risks. In Nigeria, consistent and supportive policies for renewable energy could reduce uncertainty and encourage investment by providing investors with greater confidence in the stability of their returns. For instance, policies that offer guarantees or subsidies for renewable energy projects could help offset the risks associated with exchange rate volatility (Carrière-Swallow et al., 2023). Overall, the Theory of Investment under Uncertainty underscores the need for a stable macroeconomic environment and consistent policy support to foster renewable energy investment in Nigeria.

Sustainable Development Theory

Theories on sustainable development are rooted in the concept of meeting the needs of the present without compromising the ability of future generations to meet their own needs, as articulated by the World Commission on Environment and Development (WCED) in 1987. The sustainable development theory emphasizes the integration of economic growth, environmental protection, and social equity in development planning and policy-making (UNDP, 2022). The theory provides a critical framework for understanding the interconnections between renewable energy investment, exchange rate stability, and long-term economic development. Renewable energy investment is essential for reducing the environmental impacts of fossil fuel consumption, such as greenhouse gas emissions and air pollution. By transitioning to cleaner energy sources, countries can achieve more sustainable economic growth that aligns with global environmental goals (Ajayi & Ajanaku, 2018). Furthermore, the theory highlights the role of social equity in the development process. In Nigeria, access to energy is unevenly distributed, with rural and underserved communities facing significant energy poverty. Investing in renewable energy can help address these disparities by providing affordable and reliable energy access to marginalized populations, thereby promoting social inclusion (Akinbami et al., 2022). This approach is consistent with the broader goals of sustainable development, which seeks to create more equitable and resilient societies. However, according to Olawuyi (2020), this theory also underscores the challenges of balancing economic, environmental, and social objectives. Exchange rate fluctuations can undermine the economic feasibility of renewable energy projects, particularly if they lead to higher costs for imported technologies. This research is anchored on this theory. This is because it emphasis the interconnections between renewable energy investment, exchange rate stability, and long-term economic development.

Empirical Literature

Asemota and Olokoyo (2022) utilized secondary data from the World Development Indicators for the period between 1980 and 2021 and the ARDL (autoregressive distributed lag) model to assess the long-term impact of renewable energy financing on sustainable industrial development in Nigeria. The results indicated that external debt financing for renewable energy, as well as the use of energy from combustible waste and alternative nuclear sources, positively and significantly influenced the development of Nigeria's industrial sector. Conversely, funding renewable energy through taxation and donations, along with the use of hydroelectric power, did not significantly contribute to sustainable industrial development in the country.

Aderemi et al. (2022 explored the long-term relationship, causal direction, and stochastic dynamic interactions between clean energy supply and industrial development in Nigeria. The findings revealed a significant negative relationship between clean energy supply and manufacturing value added, indicating that the current supply of clean energy negatively impacts the country's manufacturing sector. The study also showed that electricity production from hydroelectric sources has not contributed to industrial development in Nigeria. Additionally, there was no feedback relationship between clean energy supply and industrial development. The stochastic analysis further suggested that shocks to manufacturing value added have a considerable influence on the behavior of clean energy supply, and vice versa.

Venkatraja (2020) analyzed the relationship between renewable energy and economic growth in the *BRIC* countries (Brazil, Russia, India, and China) from 1990 to 2015 using a panel regression model. The study's results indicated that an increasing share of renewable energy, particularly in total energy consumption and electricity production, negatively affected economic growth within these countries during the study period. This was contextualized within the framework of the 1997 Kyoto Protocol.

Onabote et al. (2020) emphasized the importance of green energy in mitigating global warming, focusing on the long-term interaction between various sustainable energy sources, green energy financing options, and economic growth in Nigeria from 1982 to 2014. Using the Johansen-Joselius and Engle-Granger methods of cointegration, the study found that the contributions of alternative nuclear energy and hydroelectric power to the Nigerian economy were negative. However, the financing options revealed that net official development assistance had a positive impact on economic growth, whereas net tax on products (less subsidies) and external debt did not contribute to the country's economic growth.

Troster et al. (2018) used the Granger causality approach and Vector Error Correction Model (VECM) to examine the causal relationship among renewable energy consumption, oil prices, and economic growth in the United States. The study found bidirectional relationships between the variables, with renewable energy having a more significant impact on driving economic growth compared to oil. Another study by Chirambo (2018) employed a descriptive research method to investigate various innovations aimed at improving access to clean energy in Sub-Saharan Africa in a sustainable manner. The study emphasized the need for a regional regulatory institution to monitor progress in both climate change and clean energy, thereby taking strategic steps towards achieving Sustainable Development Goal 7.

A study by Akinbo (2017) attributed the challenges faced by small and medium-sized industries in Nigeria to insufficient funding. The study explored various mechanisms for financing renewable energy projects, utilizing T-tests to draw inferences from both financiers and developers. The research employed the ordinary least squares (OLS) method to identify that factors such as project size, technology, financial instruments, policy mechanisms, and financing strategies are crucial in driving private investment in renewable energy projects in Nigeria. The study further recommended that the government seek support from international development banks and donors to finance renewable energy projects, which could spur financial market development and economic growth.

Donastorg et al. (2017) argued that developing countries could achieve economic sustainability by ensuring consistent access to clean and reliable energy, thereby reducing dependence on depleting fossil fuels. The study identified key obstacles to renewable energy transformation, including limited access to financing, a lack of technical knowledge and management expertise, and weak legal and political frameworks. The authors explored various funding sources, including private, public, and financial markets, concluding that decision-making regarding renewable energy technology and funding should not be left solely to the government; rather, it should involve all key stakeholders.

Methodology

This research adopted ex post facto research design because we used data exclusively from publicly available data for all the variables used. Data for sustainable development, renewable energy investment and exchange rates were extracted from the World Development Indicators (WDI), (2023), a publication of the World Bank. While sustainable development was measured from two perspectives (mortality rate of under 5 per 1000 – MORT and carbon emission CO2E), renewable investment was measured by renewable energy investment (REIN) and renewable investment in agriculture and afforestation (RAIV). Exchange rate was also captured from two dimensions (nominal effective exchange rate – NEER and real effective exchange rate – REER).

Model Specification

Functionally, the relationship between sustainable development is expressed in equation form as

SD = f(RI; ER) …………………………………………. (i)

Where SD = sustainable development; RI = renewable investment and ER = exchange rate. However, these variables are further decomposed as follows:

SD = (MORT; CO2E) ………………………………………. (ii)

RI = (REIV; RAIV) ………………………………………… (iii)

ER = (NEER; REER) ……………………………………… (iv)

Stated in econometric form, the models for this study are as shown in equations (v) and (vi), with some of the variables having outliers transformed logarithmically as stated below;

$MORT = \beta_0 + \beta_1 LOGREIV + \beta_2 LOGRAIV + \beta_3 NEER + \beta_4 REER + \beta_5 LOGGDPR + \mathcal{E}$ … (v) and,

$LOGCO2E = \beta_0 + \beta_1 LOGREIV + \beta_2 LOGRAIV + \beta_3 NEER + \beta_4 REER + \beta_5 LOGGDPR + \mathcal{E}$ (vi)

Where:

MORT = mortality rate of under 5 per 1000, CO2E = carbon emission, REIV = renewable energy investments, RAIV = renewable investment in agriculture and forestry, NEER = nominal effective exchange rate, REER = real effective exchange rate, GDPR = Gross Domestic Product (control variable), β_0 = regression constant; β_{01} …… β_6 = regression coefficients, LOG = logarithm

The variables used in this study are checked for normality in distribution and other statistical properties, correlations, stationarity and long run relationship with descriptive statistics, Pearson's correlation, Augmented Dickey Fuller (Dickey & Fuller, 1979) technique and the Autoregressive Distributed Lag (ARDL) Bound test respectively. The outcome of the stationarity tests revealed a mixture of order 1(0) (level) and 1(1) (first difference hence the ARDL long and short run (Error Correction Mechanism) forms were used to determine the effect of independent on the dependent variables.

Results and Discussion

We report the results of econometrics analysis of the research data in this section, including the descriptive statistics, correlation coefficients, stationarity test, long run relationship test, the ARDL long and short run forms results and selected post-estimation tests.

Re-estimation Tests and Diagnoses

Descriptive Statistics

Table 1 contains the list of selected descriptive statistics of the research variables.

Table 1: Descriptive Statistics for Models 1 and 2

	MORT	LOGCO2E	LOGREIV	LOGRAIV	NEER	REER	LOGGDPR
Mean	136.9642	1.827875	1.892992	5.368186	218.2173	101.7103	11.56821
Skewness	0.531768	-0.135546	0.371243	-0.009442	1.017047	-0.186274	-0.689711
Kurtosis	2.314175	1.347036	2.644120	1.600838	2.492662	1.889946	2.167938
Jarque-Bera	1.601463	2.805782	0.677937	1.958011	4.394933	1.371012	2.595132
Probability	0.449001	0.245885	0.712505	0.375685	0.111084	0.503835	0.273196
Observations	24	24	24	24	24	24	24

Source:Author's Excerpts from E-Views 12 (2024)

From the table, **t**he mean values suggest that the average mortality rate (MORT) is relatively high at 136.96 per 1000 under-5 children, which could indicate underlying public health challenges in the region. The skewness and kurtosis values for most variables are close to 0 and 3, respectively, indicating that the data is approximately normally distributed, except for NEER, which is positively skewed, suggesting that higher values are more common. The probability values for the Jarque-Bera test indicate that the null hypothesis of normality cannot be rejected for all variables. This means that the variables follow a normal distribution, which is a good sign for the validity of the regression analysis. There are 24 observations in all.

Correlations

The correlation coefficients are tabulated on Table 2.

Table 2: Correlation Coefficients

	MORT	CO2E	LOGREIV	LOGRAIV	NEER	REER	LOGGDPR
MORT	1	NA					
LOGCO2E	NA	1					
LOGREIV	0.520700	-0.766844	1				
LOGRAIV	-0.943503	0.912308	-0.581186	1			
NEER	-0.800657	0.766529	-0.398060	0.865083	1		
REER	-0.918561	0.876673	-0.604665	0.903569	0.688207	1	
LOGGDPR	-0.984819	0.884514	-0.587569	0.932841	0.725369	0.931704	1

Source: Author's Excerpts from E-Views 12 (2024)

There is a strong negative correlation between all the variables and mortality rate (MORT) although only the correlation of LOGREIV move in the same direction. The others move in opposite direction. The reverse is the case for LOGCO2E where the only negative correlation is that of LOGREIV

Test of Stationarity

Table 3 is the results of the ADF stationarity test for all the variables.

Table 3: ADF Stationarity Test Results

Variable	At Level @5%		At First Difference @5%		Order of Stationarity
	ADF Stat	Prob.	ADF Stat	Prob.	
MORT	-3.241113	0.0332	-	-	1(0)
LOGCO2E	-1.241261	0.6382	-5.108867	0.0005	1(1)
LOREIV	-2.546639	0.1182	-5.889351	0.0001	1(1)
LOGRAIV	-0.048408	0.9438	-3.697630	0.0126	1(1)
NEER	- 2.107537	0.3998	-	0.0005	1(1)

			4.638140		
REER	-1.723322	0.4069	-4.936602	0.0007	1(1)
LOGDPR	-5.295363	0.0003	-	-	1(0)

Source: Author's Excerpts from E-Views 12 (2024).

Whereas MORT and LOGDPR are stationary at level I(0), LOGCO2E, LOGREIV, LOGRAIV, NEER, and REER are not stationary at their levels but become stationary after first differencing (I(1)). This implies that these variables are only stable over time after accounting for trends, making them suitable for ARDL modeling. The stationarity test results are crucial as they justify the use of ARDL models, which are appropriate when variables are integrated at different orders (I(0) and I(1)).

Test of Long -run Relationship

The ARDL Bound cointegration test results for the two models are as shown in table 4

Table 4: ARDL Bound Test Results

Model 1					Model 2				
Dependent Variable = **MORT**					Dependent Variable = **LOGCO2E**				
Test Statistic	Value	Significant	1(0)	1(1)	Test Statistic	Value	Significant	1(0)	1(1)
F – Statistic	40.84632	10%	2.26	3.35	F – Statistic	4.003645	10%	2.26	3.35
K	5	5%	2.62	3.79*	K	5	5%	2.62	3.79*
		2.5%	2.96	4.18			2.5%	2.96	4.18
		1%	3.41	4.68			1%	3.41	4.68

*Cointegration exists

Source: Author's Excerpts from E-Views 12 (2024)

For Model 1 (MORT), the F-statistic is 40.84632, which is significantly higher than the upper bound critical value at all significance levels (1%, 2.5%, 5%, and 10%). This indicates a strong long-run relationship between mortality rate (MORT) and the independent variables (renewable investments, exchange rates, etc.). Similarly, for Model 2 (LOGCO2E), the F-statistic is 4.003645, which is higher than the upper bound critical value at the 5% significance level. This also suggests a long-run relationship between carbon emissions (LOGCO2E) and the independent variables. Hence, the ARDL Bound test results confirm the presence of long-term co-integration among the variables in both models, validating the use of the ARDL approach in this study. This long-term relationship implies that even if short-term fluctuations exist, the variables will converge to equilibrium over time, reinforcing the importance of renewable investments and exchange rate policies in achieving sustainable development.

Effect of RI and ER on SD

The ARDL results for Models 1 and 2 are compressed in Table 5.

Table 5: ARDL Models' Results for Models 1 and 2

Model 1: Effect on MORT							
Method = ARDL. Dependent Variable = MORT							
Variable	Short-run Effect			Long-run Effect			
	Coeff.	Prob.	Decision	Variable	Coeff.	Prob.	Decision
D(LOGREIV)	-6.798467	0.4572	Insignificant	LOGREIV	265.751696	0.7058	Insignificant
D(LOGRAIV)	-1.816061	0.0343*	Significant	LOGRAIV	-70.989743	0.5860	Insignificant
D(NEER)	-0.009240	0.0005*	Significant	NEER	0.361187	0.5915	Insignificant
D(REER)	-0.008787	0.5377	Insignificant	REER	0.343467	0.6954	Insignificant
D(LOGGDPR)	13.384401	0.0539	Insignificant	LOGGDPR	-523.195512	0.4268	Insignificant
CointEq(-1)	0.025582	0.5576	Insignificant	C	6095.193173	0.3930	Insignificant
R^2	0.638716	F-Stat	40.84632	DW Stat	1.920706		
Adjusted R^2	0.595734	P(F-Stat)	0.000000				
Model 2: Effect on LOGCO2E							
Method = ARDL. Dependent Variable = LOGCO2E							
Variable	Short run Effect			Long-run Effect			
	Coeff.	Prob.	Decision	Variable	Coeff.	Prob.	Decision
D(LOGREIV)	-2.364818	0.0000*	Significant	LOGREIV	-4.189907	0.0081*	Significant
D(LOGRAIV)	0.060801	0.1278	Insignificant	LOGRAIV	-0.614177	0.0384*	Significant
D(NEER)	-0.000254	0.0170*	Significant	NEER	-0.000819	0.1170	Insignificant
D(REER)	0.000435	0.4589	Insignificant	REER	-0.005289	0.1591	Insignificant
D(LOGGDPR)	-0.123451	0.2397	Insignificant	LOGGDPR	-0.397990	0.3099	Insignificant
CointEq(-1)	-0.310187	0.0137	Significant	C	11.828476	0.0189	Significant
R^2	0.784726	F-Stat	11.08604	DW Stat	1.859487		
Adjusted R^2	0.704920	P(F-Stat)	0.000092				

Source: Author's Excerpts from E-Views 12 (2024).

Effect of RI and ER on MORT

On the short run, the ARDL results show that LOGRAIV has a significant negative effect on mortality rate (MORT), with a coefficient of -1.816061 (p = 0.0343). This suggests that an increase in LOGRAIV correlates with a reduction in the mortality rate of children under five. Secondly, D(NEER) has a significant negative effect on MORT in the short run, with a coefficient of -0.009240 (p = 0.0005). This indicates that an appreciation in the NEER reduced MORT significantly. However, the effects of

LOGREIV, REER and LOGGDPR are insignificant on the short run. In the long run, none of the explanatory variables has a significant effect on MORT. The R^2 connotes that about 64% of the changes in MORT was explained by the independent variables while the F-Statistics and its probability reveal that the research model is statistically significant. The DW statistic of 1.859487 (approx.. 2) shows that the model has no serial correlation problem. Meanwhile past year's variations in MORT are insignificantly corrected back to equilibrium at about a very low 2% rate.

Effect of RI and ER on LOGCO2E

LOGREIV has a significant negative impact LOGCO2E in the short run, with a coefficient of -2.364818 (p = 0.0000). This suggests that investments in renewable energy are effective in reducing carbon emissions, which is a key driver of climate change. Still on the short run, D(NEER) exerts a negative and significant effect on LOGCO2E (coeff = -0.000254, p = 0.0170), implying that as NEER increases, CO2E reduced during the years. The remaining variables (LOGRAIV, REER and LOGGDPR have statistically insignificant effects. In the long run, LOGREIV has a negative and significant effect on LOGCO2E such that as the former increases, the latter decreases. Additionally, LOGRAIV significantly reduces LOGCO2E, with a coefficient of -0.614177 (p = 0.0384). This outcome indicates that sustained investment in these sectors leads to long-term environmental benefits, likely through carbon sequestration and reduced deforestation. However, NEER, REEr and LOGGDPR have no significant effect on LOGCO2E.

The R^2 connotes that about 78% of the changes in CO2E was explained by RI and ER variables. The F-Statistics (11.08604) and its probability (0.000092) reveal that the research model is statistically significant. The DW statistic of 1.859487 (approx..2) also shows that the second model has no serial correlation problem. Meanwhile past year's variations in LOGCO2E are significantly corrected back to equilibrium at about 31% rate.

Post-Estimation Tests

We subjected our results to selected post-estimation tests, including residual normality, serial correlation and heteroscedasticity tests.. Table 6 is the summary of the results of these tests

Table 6: Post-Estimation Tests Results

Test	Model	Statistics	Prob.	Decision
Jarque-Bera Residual Normality Test	Model 1	2.581500	0.275064	Normally distributed
	Model 2	0.218076	0.896688	Normally distributed
BG Serial Correlation (LM)	Model 1	2.362345	0.1497	No serial correlation
	Model 2	1.710949	0.2254	No serial correlation
BPG Test of Heteroscedasticity	Model 1	0.812428	0.6246	Homoscedastic
	Model 2	1.476601	0.2533	Homoscedastic

Source: Author's Excerpts from E-Views 12 (2024).

With all the probabilities of their statistics (>0.05 significance level), Table 6 reveals that residuals of the two models are normally distributed, without serial correlation and heteroscedasticity. This further provides support for the robustness of our study.

Discussion of Findings

Effect of Renewable Investment and Exchange Rate on Child Mortality

Our study reveals that, on the short-run, the effect of renewable investments in agriculture and forestry (LOGRAIV) on mortality rate (MORT) is statistically significant and negative. This finding suggests that an increase in renewable investments in agriculture and forestry leads to a reduction in the mortality rate among children under five. One possible explanation for this result is that renewable investments in agriculture and forestry contribute to improved food security and nutrition. Agriculture and forestry investments often involve practices such as sustainable farming and reforestation, which enhance food availability and quality. Improved nutrition directly impacts child health, leading to a reduction in mortality rates. Moreover, these investments can improve environmental conditions by reducing deforestation and promoting sustainable land use, which are associated with better air and water quality. Cleaner environments reduce the prevalence of diseases like respiratory infections and waterborne illnesses, which are significant causes of child mortality (FAO, 2020). Therefore, the short-run effect of these investments on reducing mortality can be attributed to the direct benefits of improved environmental and health conditions facilitated by sustainable agricultural practices.

Secondly, the nominal effective exchange rate (NEER) also shows a significant negative effect on mortality rate (MORT) in the short run. This indicates that an appreciation in the NEER, which strengthens the local currency, is associated with a decrease in child mortality. When the local currency appreciates, the cost of imported goods, including essential health commodities like medicine, vaccines, and nutritional supplements, decreases. This makes these goods more affordable and accessible, leading to improved health outcomes and lower mortality rates (IMF, 2021). Additionally, a stronger currency can reduce inflationary pressures, stabilizing prices and ensuring that essential goods remain within reach of the population. This economic stability supports better health infrastructure and services, contributing to the observed reduction in mortality rates. Therefore, the short-run effect of NEER on reducing mortality can be linked to the economic benefits of currency appreciation, which enhances access to vital health-related goods and services.

We found that the long-run effects of most variables on MORT, to be statistically insignificant. This suggests that while these factors may have short-term effects on mortality, their long-term effects are less pronounced or more complex than anticipated. One possible reason for the insignificance of LOGREIV and NEER in the long run is that the immediate benefits of renewable investments and currency appreciation may diminish over time as other factors, such as economic volatility, policy changes, and external shocks, come into play (Narayan & Smyth, 2006). Renewable investments may initially reduce mortality by improving health and environmental conditions, but these effects could be offset in the long run by factors such as population growth, urbanization, and climate change, which introduce new health challenges. Similarly, the long-term effects of NEER on mortality may be diluted by fluctuations in global markets, trade policies, and domestic economic conditions that affect the stability and purchasing power of the local currency.

The insignificance of REER and LOGGDPR in the long run could also be attributed to the fact that these variables are influenced by a wide range of factors that go beyond the scope of this study. For example, the real effective exchange rate (REER) is affected by inflation rates, trade balances, and foreign direct investment flows, which may have varying impacts on mortality over time (Fosu, 2017).

Effect of Renewable Investment and Exchange Rate on CO2 Emission

Renewable energy investments significantly reduce carbon emissions in the short run. This finding is consistent with the global trend where increased investments in renewable energy technologies, such as solar, wind, and hydroelectric power, displace carbon-intensive fossil fuels. The immediate effect of this transition is a reduction in greenhouse gas emissions, as renewable energy sources produce little to no carbon dioxide during operation (IPCC, 2018). The effectiveness of these investments in reducing emissions is particularly pronounced in the short run, where the shift from fossil fuels to renewables directly impacts emission levels.

Moreover, renewable energy investments often lead to improvements in energy efficiency, which further contributes to the reduction of CO2 emissions. As Nigeria and many other developing countries invest in renewable energy infrastructure, they also tend to adopt energy-efficient technologies and practices, which lower overall energy consumption and emissions. Thus, the short-run reduction in carbon emissions can be attributed to the immediate environmental benefits of transitioning to renewable energy sources and improving energy efficiency.

In the long run, renewable investments in agriculture and forestry also significantly reduce carbon emissions. This finding suggests that sustained investments in these sectors contribute to long-term environmental benefits, primarily through carbon sequestration and sustainable land management. Forestry activities, such as reforestation and afforestation, play a crucial role in absorbing atmospheric CO2, acting as carbon sinks (UNFCCC, 2022). Over time, the cumulative effect of these activities results in a significant reduction in overall carbon emissions. Additionally, sustainable agricultural practices that reduce the use of chemical fertilizers and promote organic farming contribute to lower emissions of greenhouse gases, including CO2 and methane. The long-term effect of these investments is therefore linked to their ability to enhance carbon sequestration and reduce emissions through sustainable land use and agricultural practices.

However, the long-run effects of variables like NEER, REER, and LOGGDPR on carbon emissions were also found to be statistically insignificant. This could indicate that while these variables may influence carbon emissions in the short run, their long-term effects are less straightforward (Stern, 2006). The insignificance of NEER and REER in the long run may also reflect the complex and dynamic nature of exchange rates, which are influenced by a wide range of economic, political, and social factors. While currency appreciation or depreciation may affect the affordability of energy technologies and the competitiveness of green industries in the short run, these effects may be offset or compounded by other macroeconomic variables in the long run (Balassa, 1964).

Conclusion and Recommendations

This study explores the effects of renewable investments and exchange rates on sustainable development in Nigeria, focusing on child mortality rate and carbon emissions as key indicators. Using the ARDL model, the study analyzes both short-term and long-term relationships between these variables. The significant findings reveal that renewable investments in agriculture and forestry reduce child mortality in the short run, and investments in renewable energy effectively decrease carbon emissions in both the short and long run. Additionally, the nominal effective exchange rate is found to reduce child mortality in the short run. However, many of the long-term effects of these variables were found to be statistically insignificant, suggesting complex and contingent relationships between economic, environmental, and health outcomes.

The findings indicate that renewable investments, particularly in agriculture, forestry, and energy sectors, play a crucial role in reducing child mortality and carbon emissions, thereby contributing to sustainable development. The significant short-run effects suggest that these investments can provide immediate benefits to public health and the environment. However, the lack of long-term significance effect of several variables suggests that these benefits may be influenced by other factors over time, such as economic volatility, policy changes, and global market dynamics.

Based on these findings, this study strongly suggests that Nigerian government should continue to prioritize and increase investments in renewable energy and sustainable agricultural practices, as these have been shown to yield immediate benefits in reducing mortality and emissions. Also, to ensure the long-term effectiveness of these investments, it is essential to develop robust policy frameworks that integrate renewable energy and sustainable agriculture into broader economic and environmental strategies. There is need for policymakers to ensure that currency appreciation is leveraged to improve access to essential goods and services. Finally, the government should encourage technological innovation and advancements within renewable energy and agriculture sectors which can help sustain the positive effects observed in the short run, ensuring they persist in the long term.

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